Chapter

Green Transportation in Green Supply Chain Management

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Abstract

Organizations of the present day have directed their work patterns by acquiring the approach of green supply chain management (GSCM), in order to combat harmful environmental concerns. The most prominent reason behind the adoption of green strategy is to reduce the burden of the polluted environment. It is a concept which identifies the relationship between the supply chain operations and the natural environment. The present chapter provides a detailed discussion regarding the application of green transportation in green supply chain management, while shedding light to the evolution of green supply chain management, and its principle along with the factors that support total quality environmental management. The overall discussion is focused by elaborating the examples of green transportation in GSCM. The discussion revealed that most of the international markets prioritize the emission of gas, rather than focusing on implementing the green technologies in transportation. Slow steaming, voyage optimization, and efficiency in port operations are some of the major recent trends of green transportation identified in green supply chain management. However, some of the common examples of green transportation in GSCM dalsey hillblom lynn (DHL) model of green transportation and ingvar kamprad, elmtaryd agunnaryd (IKEA) model of green transportation which serves as the major initiatives in the management of green transportation.

Keywords: green transportation, green supply chain management, environment, organizational operations, drivers and barriers, green energy

1. Introduction

Green supply chain management (GSCM) has acquired integrating importance for managing the organizational practices with environmental concerns. Some organization's supply chain managers still need to understand that reducing the environmentally harmful attributes will not only be beneficial for the society but will also improve their logistic operations [1]. The most important reason behind adopting the greening strategy in supply chain management is to reduce the burden of polluted environment caused by the wastage of industries. Undoubtedly, logistic operations have greatly contributed in raising the level of air pollution which affects both the environment and also the economy.

GSCM has been defined differently by various researchers, for instance, Sarkis [2] defined GSCM as the process where all the organizational operations and innovations related to supply chain management are deliberated in accordance with the environment, whereas, for Dwivedi [1], GSCM includes the fundamental industrial activities

such as material recycling, reusing, and substituting. Similarly, Shan and Wang [3] defined GSCM as a set of processes involving the activities of customer's and manufacturer's course of orders, product designs, procurement activities, distributions, and logistics while corresponding to the principles of eco-friendly environmental management [3]. Sharma et al. [4] explain the concept of GSCM as an integration of safe environment in designing products, sourcing and selection of material, production process, and final product delivery to the customers as well as disposal of wasted products.

According to Weeratunge and Herath [5], GSCM is the component which reflects the relationship of natural environment and supply chain operations. It further involves all the external or internal factors which influences the management operations of logistics and measures the performance of the supply chain process according to environmental aspects. Due to the extensive customer demands, organizations are shrinking to the core of Red Ocean and seek to establish new businesses or techniques to attract customers. In recent years, companies have shown an immense interest toward adapting the strategies of environmentally friendly methods by producing goods and services that meet the criteria of safe environment [5]. By shifting toward ecological systems, organizations can enhance the efficiency of production, achieving the competitive advantage and reducing the impact of harmful factors of the environment [4, 6].

2. The evolution of GSCM

According to Intravaia and Viana [7], environmental pollution issue has emanated exponentially since the 1960s. The reason behind this alarming situation was the absence of law specifically designed to manage environmental risks and damages, such as ISO 14000 which aims to manage and monitor the impact of environments. The concept of GSCM was contemplated in 1996 by the US Department of Manufacturing Research Consortium in the University of Michigan States. The main approach behind this concept was to regulate the environmental effects and resource allocation in the supply chain process [8]. The Revolution of GSCM measures enhances the quality of services and makes the supply chain process cost efficient by implementing precautionary steps with respect to environmental safety [9].

In 2007, Turk institutions of economics and World Bank proposed the index containing the performance of logistic operations which evaluated the level of performance and development of different countries. This performance index was complied with various components such as customer's efficiency and management control, quality of transportation and infrastructure, logistic services, time frequency for shipment and delivery, tracing and tracking facility of the consignment, and ability to manage cost-efficient shipments [10].

The early concept to adopt the GSCM is to provide humans with the standard lifestyle by reducing the health risking hazards resulting in increased consumer trust [5]. According to Gandhi and Vasudevan [11], green management is considered as one of the significant practices to save the energy consumed during the supply chain processes. The revolution of GSCM resulted in spreading awareness about the environmental security, following which several industries are now implementing the waste-free and emission-free concept of energy. This implementation will help them to ensure the management of green environment for their customers who pay high concern toward global warming and climatic changes. Onurlubas [12] asserted that the evolution of green management has optimized organizations to pay more attention toward adopting the green practices to enhance the efficiency of environment. The reason behind this excessive concern is that consumers have

begun to question their practices with respect to their impact on climatic and environmental changes, thus, socially responsible and conscious organizations are revolutionizing their manufacturing processes by introducing and implementing green production strategies [3].

3. Principles of GSCM and green transportation

GSCM practices help in the reduction of elements which negatively impact the supply chain process. These practices bring along various financial or social benefits as well as environmental advantages [13]. Consumers have shown high interest toward the products of companies who work on ecologically friendly production and marketing activities.

Along with the integration of GSCM, organizations are highly focused on synthesizing the green transportation in their logistic operations. Transportation is currently the most prominent cause of increased global warming, health haphazard, and emission of gases. These problems have pressurized government to devise their policies for environmental safety in order to reduce the damage caused by the emission of greenhouse gases [14]. The broader concept behind the implementation of the green practices in supply chain management is to eliminate excessive use of material and production of carbon dioxide (CO_2) gas and abolish the use of recycled goods [6]. GSCM practices have also included many diverse dimensions such as the corporate engagements with the customers and suppliers which are helpful in integrating the green practices, green transportation, and reverse logistics [15].

Successful GSM practices are based on some important principles that revolve around useful practices resulting in high quality assurance and cost-effectiveness. These practices include as follows.

3.1 Green transportation

Globally, the demand for green transportation has been increasing rapidly. The purpose for initiating green transportation is the high emission of CO_2 gas since the 1990s, which is consequently risking the environment through freight transportation. It has increased with the percentage of 71% in 2016 and is anticipated to increase 50% more till the year 2050 [16].

Green logistics and green transportation have been the striking topics in today's manufacturing market. However, the acquisition of preventive measures among various countries included different strategies [10]. For example, Norway, Sweden, the United Kingdom, Switzerland, and Ireland have been working on the reduction of fuel and oil consumption to reduce environmental pollution [10]. The practices of green transportation and logistical reverse activities are the opportunities for organizations to boost their growth and reduce overall production costs. The efficiency of logistics can be further achieved by promoting the efficiency of transportation system, i.e., through green transportation [17].

3.2 Green procurement and logistics

Green procurement refers to the purchasing of products and services that are less harmful for the environment. The selection of the procurement is based on the quest of quality products and services that supports positive environmental and health concerns in competitive prices. In the early years of 2000, regulatory authorities amended their procurement standards by taking in environmental concerns

into account while purchasing goods and services. Most of the bureaux or departments were advised to refrain from using disposable items that are not eco-friendly and were motivated to purchase products that are developed through highly recycled content and maximum durability. Green procurement further includes products that are comparatively low in emitting toxic and poisonous substances [18]. It is a crucial step for any organizations to ensure that the purchasing of all their raw materials should be in accordance with the environmental objectives. The management of procurement and green purchasing are assigned to audit and inspect whether their supply chain department is implementing green practices in purchasing the raw materials and other purchase-related activities [15]. Generally, activities of green purchasing are complied with approaches including purchasing the goods or services that are environmentally friendly, evaluating products with internal and external auditors prior to their purchasing, or assisting the suppliers to enhance their functions in compliance with ecological goods and services [19].

Logistics on the other hand is considered as the most crucial factor in supply chain processes since it has acquired the most significant dimension for environmental impact. In logistics, the concept of green is applied to various elements such as raw material acquisition and transportation facility of outbound and inbound logistics [13]. The objective of green logistic is to eliminate the environmental effects in the logistical operations in order to achieve sustainable environmental, cultural, economic, and social advantages [10]. According to Franchetti et al. [19], there has been much debate on operations of green logistics, but industries of transportation have narrowed its definition. Its definition is compiled as the activities which involve the reduction of transportation cost and efficient utilization of assets, vehicles, distribution, and terminal centers.

3.3 Green warehouse

A number of green warehousing facilities are increasing promptly and shifting their operations to green practices which has also increased the cost and time allocation of the firms. The practices of managing the warehouses and inventories are the most crucial element of the logistic operations. This is simply defined as keeping the adequate amount of stock on the shelves and in the inventory, to prevent the wastage of material resulting in reduced transportation expenses and negative environmental impacts. The good inventory planning is referred to as reducing the wastage and efficiencies and decreasing the costs of tangible and intangible goods [13].

Many companies have realized the benefits of green warehousing and are keen to implement them in their supply chain process. Certain manufacturing industries have allocated these practices to minimize carbon consumption, environmental pollutions, and production cost, as well as to achieve the target of socially responsible organization [20].

3.4 Green design

Ecological or green designs are the set of activities which include the use of goods that are according to environmental discipline. An ecological design aims to establish a secure and clean factory with respect to reduced cost of disposal, health safety and minimum environmental risk factors [13], leading toward enhanced quality of services and products, cost-efficient production and while promoting a strong public image of brand and company. According to Ren et al. [21] by implementing eco-friendly practices, green design supply chain management can control about 80% of environmental impact, as Rostamzadeh et al. [20] asserted that it is associated with the overall flow of supply chain process.

3.5 Green manufacturing

Ecological production or green manufacturing is defined as the efficient production system which causes little to no pollution or wastage. The efficiency of any production facility could be measured by its ability to manufacture goods with minimal defection, scrap, or reworking on the material and its ability to manage the production of goods [13]. The ecological production in the supply chain process helps to diminish the negative effects of production and brings in the environmental sustainability throughout the production life cycle. It can also improve the manufacturing operations and financial performances of the organization [17]. Integrating the green manufacturing practices will also be beneficial in reducing the cost of raw material and transportation, by the expansion of environmental safety leading toward profitable growth and large market share.

3.6 Green marketing

Other names of ecological marketing are green marketing, social marketing, environmental marketing, or sustainable marketing. The term green marketing in the context of GSCM is defined as the activities that are designed to satisfy the needs of consumers in accordance with causing minimum risk to the environment [12]. This also encourages organizations to survive in competing international or national markets [20].

There are various green marketing practices that help to ensure that natural resources and raw materials are utilized to achieve the sustainability of environment. These practices include green designing of products, green product promotional campaigns, pricing according to green practices, targeting the green markets, and green positioning of the products [22].

3.7 Total quality environmental management

The concept of total quality management is based on achieving, maintaining, and ensuring the quality of the output. It is highly focused on continuous improvement of the business-related operations and prevents the chances of failure at each step of the production in order to successfully meet the needs and demands of consumers [23].

For the quality improvement processes, the International Organization for Standardization (ISO) was established in 1987 to ensure the contribution of organizations in environmental safety according to defined standards by the ISO. These standards included useful guidelines for the organizations to ensure the quality of their products and services according to its standards [24]. There are various in-house supply chain practices that are considered as an important discipline in GSCM. Among many internal practices, total quality management is notorious for managing the environmental security. These practices require upper management guidance as it is associated with the overall life cycle management [8]. The management of organizational total quality environment has broadened the GSCM concept to various operations including green designing of products as well as infrastructure, green procurements, ecological transportations (vehicles), eco-friendly logistics, and reverse logistics as well as recycling [15]. Diagrammatic Representations of the Working of Green Transportation in the Structure of Green Supply Chain Management (**Figure 1**). **Figure 2** provides a brief overview of the cycle of green supply chain process and its relation with green transportation.

Figure 1.
The Cycle of Green Supply Chain and Its Relation with Green Transportation.

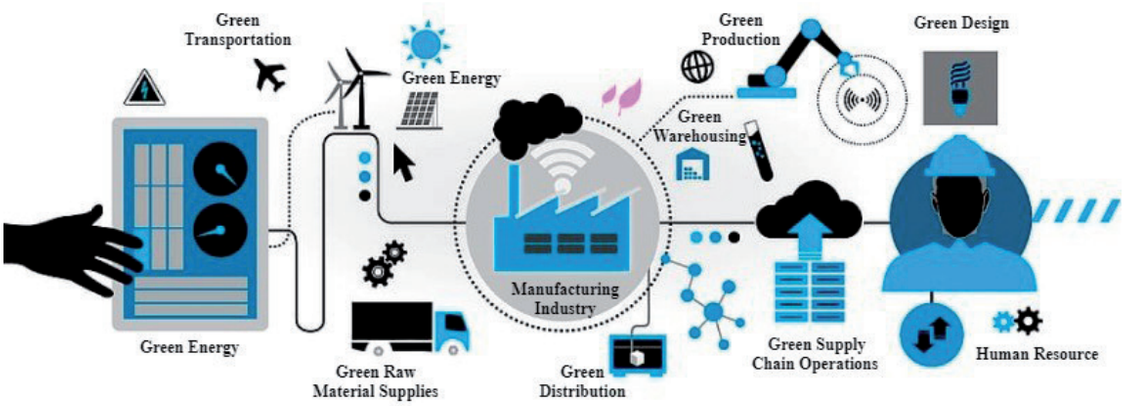

Figure 2.
The Functional Process of Green Transportation in GSCM.

4. Transportation types in supply chain management

The transportation in supply chain management was first developed through a railway transport in the nineteenth century. However, 1903 airway transports were introduced leading to the development of ocean/maritime transport in 1956, where cargo was delivered through containers via sea which gave a dramatic boom to water transportation.

Presently the concepts of supply chain management and transportation are broadly discussed and are referred to as operations that ensure the availability of goods and services when and where needed in adequate quantity [25]. In the international business world, transportation is the most dominating element in supply chain management as it influences the growth of business. Due to the intense demand of goods and services, delivering products to the end users or consumers has become the most crucial achievement for businesses.

It has been significantly noticed that, within the supply chain process, transportation plays the vital role in proving the efficiency and smooth flow of the operations. There are various services of transportation management delivering the goods to the places where

it is needed in demanded quantity. These services include air freight, road freight, railway freight, sea freight, pipeline freight, and services to and from warehouses [26, 27]. The real challenges that businesses face in transportation are feasibility and availability of viable roads to deliver goods. The most important operation in this challenge for the manufacturing industries is to optimize and modify their inventory and supply of the material in accordance to deliver the final product with the just-in-time system. This system helps to reduce the overall cost of facilities in maintaining materials required for production. Thus, today's supply chain process has become defying in meeting the long-distance consignments and ensuring the availability of supplies on time [28].

4.1 Modes of transportation

To reduce the cost of transportation and environmental risks, the quality of supply chain processes is enhanced through transportation modes such as intermodal and multimodal transportation. The intermodal transportation involves multiple modes to transport goods such as trucks, water, etc. Many organizations have shown a keen interest toward adopting the intermodal transportation in which products are transported through different medium of transportation. This mode of transportation in supply chain management has combined as one to provide the benefits such as efficiency in rail transport and flexibility in road freighting. The objectives of intermodal transportation are to reduce the emission of carbon and overall transport cost and to modify road congestion [29]. The intermodal transportation has minimized 57% of carbon emission as compared to other modes of transportation [30].

Multimodal transportation is quite similar to intermodal transport as it connects various transportation modes in a single process which ensures the cost efficiency in door-to-door goods movement under a single service provider [31]. The only difference in both modes is the number of units loaded for shipping [32]. There are further types of intermodal and multimodal transportations, which include as follows.

4.1.1 Air freight

Air transport is certainly the most expensive but the speediest freighting service among all other transportation types. It reduces the time of goods delivered to the doorsteps and is often preferred to transport the most valuable goods to the market. Bag mails, packages weighing 30 kg, and any document that could be carried through individual person are categorized as the smallest way of transportation. Globally air cargo is gaining an increasing role in international supply chain and logistics [31]. Due to the high cost of air cargo, most organizations use this mode as supplementary transportation service for the shipment of critical and urgently needed goods.

4.1.2 Road freight

Road transportation is relatively the most used type of transportation to deliver the goods via trucks, lorries, and trawlers. This is the most flexible mode, but it cannot be operated outside the roads. Road freighting is used by organizations where rapid distribution of light-weighted goods needs shipment in concise batches. The road transportation has become challenging as it has high maintenance costs of both carrier infrastructure and other repairing costs [31] and further affects environmental stability.

4.1.3 Railway freight

Railway transportation is relatively the cheapest and the least environmentally harmful mode of shipping the goods at distancing places. Globally, China

is recognized as among the best railway service providers. The railway system of China contributes 100% of transportation efficiency to the online marketing and product delivery [27]. Railway transportation offers skilled alternatives to road freight since its operations are partially lower cost and electrified which is economically and ecologically beneficial [29]. According to Romanow [28], railway freight, despite of its cost-efficient service, still lacks timely consignment deliveries. Thus, it is observed that without the adequate and necessary improvement in railway systems, pursuing consumers would be challenging.

4.1.4 Ocean freight

Since 1990, international trade occurs via ocean freight; this mode of shipment has risen to 65% which has driven the logistic managers with significant challenges in the selection of carrier to transport goods [33]. According to Dettmer et al. [29], the rates of transportations with the category of containerized products have been decreased exponentially since the last decade, making ocean freight as the cheapest mode of transporting products. Researchers such as Waller, Meixell, and Norbis [33] asserted that about 0% of the freights are transported via ocean as 25% of heavy products are delivered to international destinations. The most common ocean cargos include container ships, cargo vessels, oil tanks, bulk carriers, and general cargo ships. In a global logistics ocean, cargo vessels move ports to ports and are specialized for swift loading and unloading of the goods.

4.1.5 Pipeline

One of the important modes of transportation which has not been provided enough attention is the use of pipeline, which accounts for approximately $53 billion costs in the year 2018, specifically in the United States. The increased production of oil and gas has increased the usage of pipeline in the transmission of natural gas and oil. This has further increased the need of investments in the given area. The analysis indicated that the use of pipeline as the mode of transportation is limited and is still recognized as the small market in comparison to the overall size of the given mode of transportation [34].

4.1.6 Micromobility

Transportation modes such as e-bikes and e-scooters that are widely being used in the cities like New York and California are regarded as the eco-friendly transportation methods and are generally termed as micromobility. It is further recognized as the cheapest mode of transportation, when traveling approximately 5 miles or less, and is known to be the fastest and easy mode of transportation which does not require any license. One of the most significant characteristics of this mode of transportation is its eco-friendliness, as it does not operate through the burning of fuel [35].

4.1.7 Cable and drone

Another similar mode of transportation is the use of cable cars that are used in most of the mountainous regions. They serve as the effective mode of transportation which has met the limitations of time and cost. Hilly areas that are connected to the urban regions promote the use of cable cars as they provide them the socioeconomic benefit by reducing the barriers such as road traffic. Since they are environmentally friendly, the use of cable cars is highly promoted in various regions [36].

Another similar mode of transportation is the use of drone. The recent research conducted by the Lawrence Livermore National Laboratory (LLNL) [37] provided that the drone-based delivery is effective in reducing the emission of greenhouse gas and energy use in the transportation sector. The study further indicated that certain factors are considered in the successful use of drone. These factors include the size of the drone, the weight of the package, and the types of power plant deployed on the regional electricity grid. The use of drones is highly favorable in areas with relatively clean electricity like California [38].

5. Green transportation and its distribution

The widespread usage of green transportation has an additional scope in the distribution of goods, as it affects the quality of air, leading to additional noise generation. It further increases the chances of severe car accidents followed by its significant contribution to the global warming. According to Stern [38], in 2000, the transportation's share in the emission of global greenhouse gas was 14% which continued to grow in the succeeding years. However, following the advancement in e-commerce and the customer demands, a significant growth in the goods transportation has been observed. This has given rise to the strategic distribution of activities which offers smart solutions for the reduced carbon footprint of companies that have apparently developed a negative impact on the total costs as well as on individual life [39].

According to Ho et al. [40], the characteristics associated with the transportation are generally influenced by different factors such as shape, size, and materials. These factors are further important as they create a significant impact on the distribution process. However, better and strategically developed location patterns along with better packaging may serve as a prompt solution to overcome this impact, resulting in the decrease in amount and increase in space. The concept of green distribution can be classified under two categories, i.e., green packaging and green logistics [40].

5.1 Green packaging

The concept of sustainability is negatively affected by the increase in solid waste. Green packaging serves as the optimal solution to cater this challenge, as it is associated with the overall process of packaging life cycle [41]. Ninlawan et al. [42] provided additional information according to which green packaging can be further practiced by increasing the use of green packaging materials, promoting the reuse and recycling programs, or developing standardize methods of packaging. However, the control and management of the packaging system are held through the system evaluator indicators [43].

5.2 Green logistics

According to Jiange [41], green logistics is defined as the production and distribution of goods that are held in a sustainable manner by the inclusion of activities such as evaluation of the environmental influence of distribution methods used and reduction of the waste and its effective management along with the strategic planning of logistic activities. For Zhang and Liu [43], the development of the green logistics serves as an interconnected system and requires the cooperation of different parties including the common public, government officials, and corporate leaders. They added that the concept of green logistics is not a separate system; perhaps it is associated with the exchange of energy and information with the external world. The system is integrated through transportation and traffic, supervision and

management, and storage and delivery, along with the flow of information [41]. Green logistics majorly focuses on the direct delivery of goods to the user site, along with the bulk distribution of products rather than in small sets [42].

6. Examples of green transportation in GSCM

6.1 DHL model of green transportation

DHL is an international logistic organization operating worldwide business within 220 countries. DHL focuses on sustainability and CSR activities since 2009 and many campaigns for environmentally green initiative. *PPGoGreen* campaign program was launched to protect the environment to achieve sustainability and long-term improvement competence [44]. The vision of DHL is to develop green and sustainability in their transportation services by designing future goals to reduce the emission of greenhouse and carbon gases. Following these goals, DHL intended to enhance the efficiency in transportation by reducing carbon emission to 50%, resulting in reduction in pollution emission to 70%. DHL also initiated clean delivery and pickup services including electrified vehicles or bicycles and training suppliers and employees to follow the green transportation strategy of *Go Green* (Deutsche Post DHL Group).

6.2 IKEA model of green transportation

IKEA is one of the leading furniture manufacturers that have been working on maintaining sustainability in their overall logistic operations and committed to carry their operations with environment-friendly practices. IKEA has set vision for providing better lifestyle at home by promising high quality standards, low price, and environmental safety by not wasting natural resources. The founder of IKEA used to claim that furniture designers can design any desk within the cost of $1000 but designing a sustainable, functional, and beautiful for just $50 is marveling [32].

IKEA practices on green transportation by designing travel plans for their workers and logistic operations. The employees of IKEA are encouraged to travel through bicycles, walking, public busses, or sharing cars with their co-workers in order to support the company to achieve their vision [45]. From the transportation perspective, IKEA believes that utilizing loading shelves for transporting, the units will eliminate the space required for wooden pallets, which will reduce the overall cost of transportation. According to the sustainability report of 2019, gas emission through transportation is recorded to be 19.4% [46]. To reduce this, IKEA has set future goals to reduce 30% of greenhouse gases from their transportation services in 2020 [47] and further aims to eliminate the emission of carbon gases to 70% by 2030 [46].

7. Importance and benefits of green transportation

The practices of green transport have been on an exponential importance in green logistics. It has been identified that promoting green management and transportation has significant benefits toward economy, environmental well-being, as well as improving the organization's growth [10]. Green logistics and green transportation are important in reducing the consumption of fuel and energy as their target is to regenerate and renew the fuel instead of consuming fossil fuel.

The implementation of green practices in transportation gives cost reduction benefits for the movement of shipments, efficient vehicle allocation and planning opportunities, and natural and human resource advantages. Moreover, it further reinforces the image of the products. Green transportation further gives customer retention advantage as customer's interest has been shifted toward green products; therefore, companies have an opportunity to implement environment-friendly transportation to grab mass market [48].

8. Drivers and barriers of green transportation

Among many barriers there are two features that are considered as the main problem, which include the renewing system for electrical energy and generating fuel for vehicle that produces less emission. The historical activity of road transportation and consumption of energy has been growing rapidly which has apparently increased the challenges for the adoption of green transportation [16].

Previous studies outlined several challenges in implementing green GSCM and green transportation. Some of these barriers include unwillingness to shift logistic operations to green management, fear of investing capital for adoption of GSCM, and threats of not getting the desired return after implementation [11]. Many logistic managers only provide the training of green practices but fail to carry out their practical implementations which consequently, reduces the environment-friendly performance. To overcome these challenges, **Table 1** shows the following measures.

	Connectivity access	**Change or shift**	**Enhancement**	**Supportive tools**
Measures	Sound green practices can reduce trade barriers	Public transportation, supply chain process, rail freight, fuel and energy consumption	Efficiency in fuel consumption, alternative strategies for fuel generation, cleaner fuel	Awareness, timely monitoring, develop institutions, training
Useful instruments	Changes in policies for green transportation	Action plans to encourage more organizations, awards, recognition, and expert guide	Road maps for growth, green fuel consumption, schemes of green freight labeling	Development in curricula for undergraduate future employees, awareness campaigns, knowledge centers
Benefits	Social and economic growth, customer retention	Sustainable environment, safe living standards	R&D policies, trade and economic growth, security of energy consumption, single market	ISO, certifications for CSR activities
Operators	Governmental organizations dealing with laws for safety and sustainability of environment	Urban development, corporation of technical authorities, local governmental bodies	Transport ministries, economic centers, civil societies, environmental security centers, ports, and trading sectors	Societies: academic, civil, local Transportation ministries

Table 1.
Drivers for green transportation.

9. The role of green energy in green supply chain management

In Europe it is observed that for the suitability of cargo transportation, communication channels play a pivotal role [10]. In logistic industries, governmental bodies and shipment service providers regulate the environmental management and shipment of units to the end users. Both of these parties work to ensure the safety for the friendly environment. The concept of green transportation is derived from generating the green fuel which is less harmful for the society. The term less harmful refers to the reduction and control over the emission of carbon gases and fuel consumption to enhance the credibility of goods transportation.

Green fuel generation is a basic element to attain the benchmark of green transportation. It is observed that biomass is the best alternative against fossil fuel. It allows combining all biomass chemicals to generate an eco-friendly fuel for vehicles, which will further help in promoting green transportation. According to Douvartzides et al. [49], green diesel has proved to be an excellent alternative for the combustion of energy with rousting properties of low emission.

10. Sustainability in green transportation in green supply chain management

To differentiate the performance of supply chain operations, it is necessary to consider factors that depend on the sustainability of overall cycle of logistics, i.e., green transportation [10]. The term sustainability of transportation refers to "a set of continuous, dynamic, and integrated guidelines and policies embraces economic, social and environmental goals that are fairly distributed and used effectively to meet the needs of transport community and generations have to be summarized only in the sustainability of the nature of transportation systems" [50].

The study conducted by Heiko and Darkow [51] claimed that transportation consumes about 20% of global energy. Since it has become a challenge for logistic industries to attain sustainability in green transportation, therefore they are more focused on getting insights into the requirements and needs of their customers and instruments to support their green practices [48]. To achieve sustainability in green logistics and transportation, it has become crucial to eliminate elements such as methods that affect the autonomy of vehicles.

Sustainability in transportation can be achieved by enhancing the quality of air by reducing the emission of gases from the road transport and implementing a limit to the emission of harmful gases for all the vehicles. The following are the measures that manufacturing industries can take in their logistic and green transportation to achieve sustainability:

1. Modify the transportation system to affordable, easy, and reliable mode, which could be easy to assess by all users.

2. Implement diverse medium such as bicycles, walking, and electric vehicles (EV) and recharging stations which is implemented by IKEA stores in many countries.

3. By using hybrid and alternative fuels, vehicles could be limit in emission of carbon, which is a key element of sustainability in green transport [52].

11. Current practices in green transportation implementations in green supply chain management

The demand for green transportation has been increasing rapidly in the global world. The purpose for initiating green transportation is the emission of CO_2 gas which has been growing intensely since 1990 and consequently risking the environment through freight transportation. It has increased with the percentage of 71% in 2016 and anticipated to increase 50% more till the year 2050 [16].

Recently international markets are focused on environmental safety and sustainability by eliminating gas emission rather than promoting the implementation and practices of clean green technologies and energies in transportation [10]. The United Nations has established an agency to protect the marine cargo and shipment known as the International Maritime Organization (IMO). The responsibilities and roles of IMO are to prevent the pollution of marine that is generated during the shipment of consignments, enhance the performance of shipment, and ensure the safety and security of international transportation. For the initiative of environmental safety, the IMO has designed four ways to limit and control the emission of polluted gases. These methods include energy efficiency design (EED), energy efficiency operational indicator (EEOI), ship energy efficiency management plan (SEEMP), and market-based measures (MBM). The role of EED is to measure the reduction of emission through technical tools, whereas EEOI and SEEMP both measure the operations that should be carried forward for the purpose of mitigating the greenhouse carbon. MBM has the responsibilities to operationally and technically measure the carbon markets such as the trading system emission [53].

12. Recent trends of green transportation in green supply chain management

The demands of public for the import goods are changing dramatically. This change in demands has also shifted many manufacturing and transport industries by adopting the green technologies and seeking new ways to make their operations flexible for environmental concerns. It has been observed that reduction in fuel consumption from the large ships can significantly limit the emission of carbon.

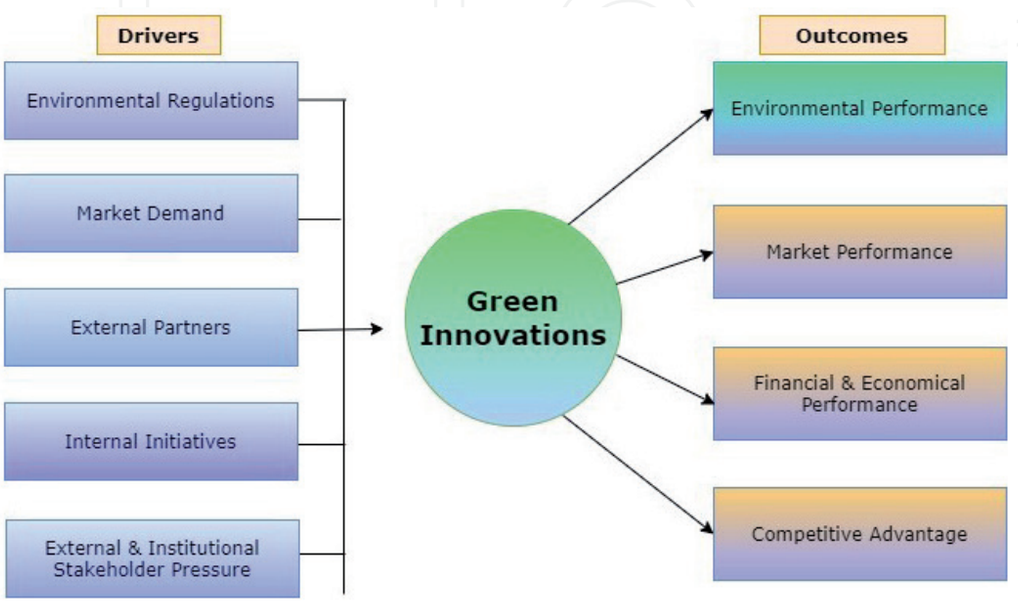

Figure 3.
Drivers and Outcomes of Green Innovations. Source: Qudrat-Ullah [56].

Figure 3 provides a brief overview regarding the drivers and outcomes of green innovations. Furthermore, there are various ways to reduce the emission of carbon, which will be discussed below.

12.1 Slow steaming

It is defined as a practice where the sails are moved slower than their designed speed. According to a study of the IMO, the emission reduction of carbon was decreased by 796 million tons in 2012 from 885 million in year 2007 worldwide. The main factor behind this reduction was the slow steaming of the cargo ships and vessels that consumes relatively low fuel which emits less carbon [54]. Different factors encouraged the adoption of slow steaming. These factors did not only focus on providing considerations toward the sustainability requirements to maintain the global supply chains but were further centered toward other important factors which include:

a. Management of the global financial crisis which ultimately caused the downturn in the global economy.

b. Another considering factor includes the high fuel costs.

c. Increasing operating cost rates.

d. Falling freight rates.

These factors resulted in the reduction of speed and minimal consumption of fuel which, in broader perspective, results in the reduced emission of greenhouse gases.

12.2 Voyage optimization

The massive use of voyage optimizer generated the need for the development of freight model. This process enhances the management and efficiencies of the ships by modifying the routes and speed of the shipping which consequently bring the ecological and economic advantages.

12.3 Efficiency in port operations

It is asserted that for mitigating the risking impacts of port management, manufacturing and transportation industries need to switch their decision to environmental sustainability from financial sustainability. It is also observed that by transportation layout, change is necessary to reduce the carbon emission such as shifting to rail tracks from road transport.

13. Future directions of green transportation in green supply chain management

Suppliers, customers, and their need of the transportation possess an important role to broaden the concept of logistics. Many companies have integrated advancement in vehicle technologies to enhance the performance of the environment and transportation of freight as well as transportation services for public. Data envelopment analysis (DEA) is observed to be an efficient method to evaluate the performance and efficiency of green practices in logistics and transportation. The

DEA model helps to measure the efficiency of the green supply chain process in terms of cost, human resource, energy, output, and carbon emission. The logistic managers need to enhance their transport system and let it lose free that will boost company growth, and vice versa it will positively influence economic growth which will result in building a healthy and strong nation [30].

Green transportation in supply chain management is further connected to the development of sustainability and green economy which can be achieved by the implementation of sustainability principles in countries. The importance of sustainability in green economy can be understood under two folds. The first includes the role of carrier in providing huge environmental impacts such as greenhouse gas emissions, while the later includes the reduction of air and noise pollutants along with the fuel management for sustainable development. It is important to emphasize that the use of resources is more important than the resources in developing a strong infrastructure.

Another important consideration must be provided to the transport infrastructure of the city which is defined through the scale of access to public transportation and the quality of roads, followed by the access point within them. These access points lead to a metropolitan area while providing important considerations toward travel time, distance, and the overall travel cost. It is noteworthy that a smooth infrastructure in transportation networks results in providing a direct effect on the scale of various local markets [50].

Other important concerns regarding the development of green transportation must be provided to the issues associated with the remaining available resources of fossils that are highly usable and can be infused in the internal combustion engines (ICE). In addition to that, the preservation and sustainable use of available reserves of lithium and other metals is highly favorable for the rapid development of green transportation since these metals are used in batteries and motors of electrical vehicles.

This transition of polluted cars to EV is characterized through the convergence of energy and mobility which may ultimately bring significant benefits to green transportation. Presently, the implementation of the propelled electric vehicles can be held through two different technologies that include fuel cells and batteries. These technologies are effective in developing the future by working on the strengths initiated through specific segments.

Battery electric vehicle (BEV) serves as the optimal solution for the short city routes, whereas fuel cell vehicle (FCV) is favorable for longer routes of huge tracks and other passenger busses. Both FCV and BEV technologies are favorable and are considered as "green" for environment since they lack the ability to produce greenhouse-related gases and other air pollutants. This is due to the fact that these technologies shift the challenge of green transportation centered for millions of individual vehicles to a central energy production place. Currently, BEV is one of the leading technologies; however, the new government policies are providing a significant interest toward the increased investments in research and development (R&D) that are expected to deliver better performance and maximum efficiency of FCV followed by their efficient recharging and better infrastructure. In the light of this, to develop green transportation for green supply chain management, it is important to develop future synergy of the abovementioned technologies which may ultimately result in best features.

Another important driver for green innovation is to provide important care to supplier's role. For the achievement of the green supply chain and green environmental targets, the right selection of supplier plays a critical role for the successful adoption and implementation of the green innovation in business firms. For the right selection of supply manager, it is important to provide firm consideration toward factors such as green purchasing abilities, green competencies, environmental management initiatives, environmental investments, and environmental

regulatory compliance followed by the end economic benefits. This is due to the fact that in supply chain management, supply-related factors play a critical role in managing the environmental processes effectively. It further supports the intervention of innovation and creativity in business process. The study of Burki [55] emphasized the selection of effective suppliers, as they play a key role in increasing firm's ability to adopt and accomplish the environmentally friendly work processes that are useful for environmental management and green innovation system.

It is further essential to prioritize the activities in the process related to green logistics and green transportation by elevating the transportation sectors. This modification will reduce the waiting time in supply chain cycle of product and simultaneously improve the efficiency of energy consumption. There are some important future implications in green supply chain management which is subsequently associated with green transportation:

1. Practices of reusing and recycling the material throughout the production cycle which will reduce the consumption of energy to minimum.

2. Seeking for the ways to minimize the wastage by utilizing minimum materials for the packaging.

3. Designing the product design that is easy to deliver. This could include the example of IKEA, who designed their packaging that require less space in shipment.

4. Purchasing the raw material that has absolute minimum or no negative impact on the environment.

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